dust suppression, air filters, personal protective gear) during construction when penetrating horizons in which erionite could occur, such as in the basal vitrophyre of the Topopah Spring tuff.

A number of other minerals present at Yucca Mountain might have associated health risks if prolonged exposures occur; however, there is no evidence suggesting a link to cancer. Therefore, the International Agency for Research on Cancer has ranked these substances not classifiable (DIRS 100046-IARC 1997, all). Some of the minerals identified and considered in establishing health and safety practices for potential repository operations include the zeolite group minerals mordenite (which is fibrous and similar in some respects to erionite), clinoptilolite, heulandite, and phillipsite. Because there is no known risk associated with the other zeolite minerals, and because they occur primarily in nonwelded units below the repository horizon, they probably do not represent a large risk. The measures implemented to mitigate risk from silica (for example, dust suppression, air filters, personal protective gear) should also protect workers from exposure to other minerals.

3.1.8.4 Industrial Health and Safety Impacts During Construction of the Exploratory Studies Facility

During Yucca Mountain site characterization activities, health and safety impacts to workers have resulted from common industrial hazards (such as tripping and falling). The categories of worker impacts include total *recordable* incidents, lost workdays, and fatalities. Recordable incidents or cases are occupational injuries or occupation-related illnesses that result in (1) a fatality, regardless of the time between the injury or the onset of the illness and death, (2) *lost workday cases* (nonfatal), and (3) incidents that result in the transfer of a worker to another job, termination of employment, medical treatment, loss of consciousness, or restriction of motion during work activities.

Site characterization activities at Yucca Mountain have had no involved worker fatalities. DOE has compiled statistics for the other types of health and safety impacts in accordance with the regulations of the Occupational Safety and Health Administration (29 CFR Part 1904) (see Appendix F, Section F.2). These statistics cover the 30-month period from the fourth quarter of 1994 through the first quarter of 1997. DOE selected this period because there was high onsite work activity in which the tunnel-boring machine was in operation in the Exploratory Studies Facility. DOE expects this condition to be characteristic of the types of activities that would occur during the construction of the surface facilities and the development of the emplacement drifts. Table 3-31 lists the industrial health and safety loss statistics for industry, general construction, general mining, and the Yucca Mountain site.

Table 3-31. Comparison of health and safety statistics for mining activities from the Bureau of Labor Statistics to those for Yucca Mountain during excavation of the Exploratory Studies Facility.[a]

Statistic	Total industry[b]	General construction[b]	General mining[b]	Yucca Mountain experience for involved workers[c]
Total recordable cases rate	7.1	9.5	5.9	6.8
Lost workday cases rate	3.3	4.4	3.7	4.8
Fatality rate	Not available	Not available	Not available	0.0[d]

a. Statistics based on 100 full-time equivalent work years or 200,000 worker hours.
b. Source: DIRS 148091-BLS (1998, all).
c. Source: Appendix F, Section F.2.
d. There have been no fatalities on the Yucca Mountain Project. However, the fatality rate obtained from the entire DOE CAIRS database for industrial activities is 0.0029 per 100 full-time equivalent work years.

3.1.9 NOISE AND VIBRATION

The region of influence for noise includes existing residences in the Yucca Mountain region and at the approximate boundary of the analyzed land withdrawal area. Noise comes from either natural or manmade sources. DOE has evaluated existing noise conditions in the Yucca Mountain region and has compiled the detected ranges of noise levels at different locations under differing conditions.

3.1.9.1 Noise Sources and Levels

Yucca Mountain is in a quiet desert environment where natural phenomena such as wind, rain, and wildlife account for most background noise. The acoustic environment is typical of other desert environments where average day-night sound-level values range from 22 decibels on calm days to 38 decibels on windy days (DIRS 102224-Brattstrom and Bondello 1983, p. 170).

Manmade noise occurs periodically in the area as vehicles travel to and from Yucca Mountain, from site characterization activities at the operations areas, and from occasional low-flying military jets. Sound-level measurements recorded in May 1997 at areas adjacent to and at the Yucca Mountain operations areas were consistent with noise levels associated with industrial operations [sound levels from 44 to 72 decibels (A-weighted)] (DIRS 101531-Brown-Buntin 1997, pp. 4-6). Table 3-32 lists estimated sound-level values for Yucca Mountain, nearby communities and cities, and other environments.

Table 3-32. Estimated sound levels in southern Nevada environments.[a]

Environment	Sound level[b] (decibels)
Calm day at Yucca Mountain	22
Windy day at Yucca Mountain	38
Rural communities (Panaca, Hadley, Rachel, Crystal Springs, Ash Springs, Cactus Springs, Alamo, Jean, Goodsprings, Sandy)	40 - 47
Small towns or rural communities along busy highways (Beatty, Indian Springs, Pahrump, Amargosa Valley, Caliente, Tonopah, Goldfield, Mercury) and at the intersection of proposed transportation routes to Yucca Mountain	45 - 55
Suburban parts of Las Vegas	52 - 60
Urban parts of Las Vegas	56 - 66
Dense urban parts of Las Vegas with heavy traffic	64 - 74
Under flight path at McCarran International Airport (0.8 to 1.6 kilometers[c] from runway)	78 - 88

a. Source: Modified from DIRS 101821-EPA (1974, p. 14); DIRS 102224-Brattstrom and Bondello (1983, p. 170).
b. Day-night average sound level.
c. About 0.5 to 1 mile.

3.1.9.2 Regulatory Standards

With the exception of prohibiting nuisance noise, neither the State of Nevada nor local governments have established numerical noise standards. Nevertheless, many Federal agencies use average day-night sound levels as guidelines for land-use compatibility and to assess the impacts of noise on people. Many agencies, including the Environmental Protection Agency, recognize an average day-night sound level of 55 decibels (A-weighted) as an outdoor goal for protecting public health and welfare in residential areas (DIRS 101821-EPA 1974, p. 3). This noise level, which has been established by scientific consensus, is not a regulatory criterion in Nevada, and could protect against activity interference and annoyance. While Nevada does not have a noise code, daytime and nighttime noise standards adopted by Washington State (WAC-173-60 and 70) for residential and commercial areas can serve as benchmarks for evaluating potential impacts based on land use. These benchmarks are 60 decibels for residential use (nighttime reduction to 50 decibels), 65 decibels for light commercial, and 70 decibels for industrial zones. As required, DOE monitors noise levels in worker areas, and a hearing protection program has been in place during site characterization. Hearing protection is used as a supplement to engineering controls, which are the primary method of noise suppression.

Sound levels that cause annoyance in people vary greatly by individual and background conditions. However, the threshold for hearing hazard, which depends on the frequency of the sound, ranges from around 65 decibels at a frequency of 4,000 hertz to about 88 decibels at frequencies of 125 and 8,000 hertz (DIRS 155778-Melnick 1998, Vol. 12, p. 18). These threshold levels assume continuous exposure for periods of hours. High risk for hearing loss occurs at 120 decibels and can result from short-term exposure of seconds to minutes. Ground transportation activities such as those associated with the Proposed Action (either rail or heavy-haul trucks) would not propagate noise levels of this magnitude to the environment.

3.1.9.3 Vibration

Ground vibration is an element of environmental assessment. Many natural phenomena (wave action on beaches, strong winds, earthquakes, etc.) as well as human activities (construction, transportation, military activities, etc.) can contribute to ground vibration. As a consequence, there is a component of background vibration that exists, generally higher in large cities than in rural communities, and lower in areas more distant from human activities. This vibration component can be altered by a change in site activities.

There are two measurements for evaluating ground vibration: peak particle velocity and root-mean-square velocity (DIRS 155547-HMMH 1995, p. 7-3). *Peak particle velocity* is the maximum instantaneous positive or negative peak of the vibration signal, measured as a distance per time (such as millimeters or inches per second). This measurement has been used historically to evaluate “shock”-wave type vibrations from actions like blasting, pile driving, and mining activities, and their relationship to building damage. The root-mean-square level is an average or smoothed vibration amplitude, commonly measured over 1-second intervals. It is expressed on a log scale in decibels (VdB) referenced to 0.000001 (10^{-6}) inch per second and is not to be confused with noise decibels. It is more suitable for addressing human annoyance and characterizing background vibration conditions because it better represents the response time of humans to ground vibration signals.

A typical background level of ground vibration is 52 VdB, and the human threshold for the perception of ground vibration is 65 VdB (DIRS 148155-Hanson, Saurenman, and Towers 1998, p. 46.17). There are three ground vibration impacts of general concern: human annoyance, damage to buildings, and interference to vibration-sensitive activities. Three categories of buildings and associated human activities have been established for the assessment of annoyance or interference impacts from ground vibration (DIRS 155547-HMMH 1995, pp. 8-2 to 8-3). Table 3-33 lists these categories along with associated benchmark vibration levels at which adverse impacts might be likely. An important element of the criteria for human disturbance is the frequency of distinct ground vibration events; the more events, the higher the likelihood of annoyance. Most environmental evaluations have focused on mass transit, where there is a high frequency of events.

Vibration criteria for structural damage in fragile or extremely fragile buildings have separate structural criteria based on peak particle velocity and an approximation of VdB that have been segregated into impulse and rail impacts. Table 3-33 lists these criteria. Building damage from ground vibration, which is rare, is associated with vibration levels that are unpleasant or disturbing long before there is any possibility of damage to the building.

Background levels of ground vibration at the Yucca Mountain site are low. Other than site characterization-related activities, there is basically a lack of the classical, manmade sources of ground vibration impacts; that is, impacts from pile driving, heavy earth-moving equipment (particularly equipment with metal tracks), and blasting.

NOISE MEASUREMENT

What are *sound* and *noise*?

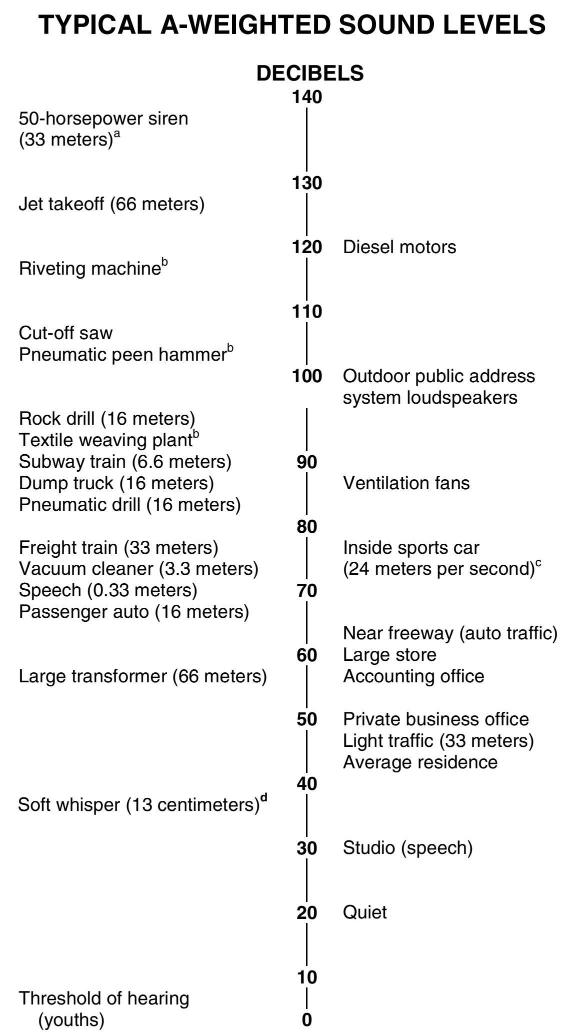
When an object vibrates it possesses energy, some of which transfers to the air, causing the air molecules to vibrate. The disturbance in the air travels to the eardrum, causing it to vibrate at the same frequency. The ear and brain translate the vibration of the eardrum to what we call *sound*. *Noise* is simply unwanted sound.

How is sound measured?

The human ear responds to sound pressures over an extremely wide range of values. The range of sounds people normally experience extends from low to high pressures by a factor of 1 million. Accordingly, scientists have devised a special scale to measure sound. The term decibel (abbreviated dB), borrowed from electrical engineering, is the unit commonly used.

Another common sound measurement is the A-weighted sound level, denoted as dBA. The A-weighting accounts for the fact that the human ear responds more effectively to some pitches than others. Higher pitches receive less weighting than lower ones. Most of the sound levels provided in this EIS are A-weighted; however, some are in decibels due to lack of information on the frequency spectrum of the sound. The scale to the right provides common references to sound on the A-weighted sound-level scale.

Source: Modified from DIRS 103233-DOE (1999, p. 3-39)



a. To convert meters to feet, multiply by 3.2808.
b. Operator's position.
c. 24 meters per second = about 50 miles per hour.
d. 13 centimeters = about 5 inches.

3.1.10 AESTHETICS

Visual resources, with nighttime darkness as a component, include the natural and manmade physical features that give a particular landscape its character and value as an environmental factor. The physical features representing the region of influence for aesthetics are those found within the approximate boundary of the analyzed land withdrawal area. Sections 3.1.3 and 3.1.5 describe the geologic and biological settings, respectively, at Yucca Mountain.

The region surrounding Yucca Mountain consists of unpopulated to sparsely populated desert and rural lands. Because much of Yucca Mountain is on the Nevada Test Site and Nellis Air Force Range with restricted public access, public visibility is limited to portions of U.S. Highway 95 near Amargosa Valley.